Description of the FAA Avionics Certification Process

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Introduction

The purpose of this document is to explain at a high level the Federal Aviation Administration (FAA) approach to the certification of avionics. This document assumes the reader is familiar with Title 14 Code of Federal Regulations (14 CFR) parts that effect the approval of aircraft by the FAA.

The document is broken into 4 sections addressing the major aspects of the certification process. These are:

- Design approvals under the Type Certificate (TC) or Supplemental Type Certificate (STC) approval processes
- Design approvals under the Technical Standard Order (TSO) approval process
- Installation approvals for initial (new) avionics following a TSO approval
- Installation approvals using the FAA Form 337 Process

Design Approvals Under The Type Certificate (TC) Or Supplemental Type Certificate (STC) Approval Processes

The process can be visualized by breaking it down into discrete steps. Please refer to DIAGRAM 1 for an overview of the process. Please note, the process is more continuous than the diagram implies and it has feed-back processes that can not be shown easily on a diagram.

A New Idea

The first step is the existence of a new idea for avionics. This idea is most often a derivative of an existing system. However, introduction of new technologies creates the need for all new avionics. A good example of this would be GPS Navigation

Market Assessment

The first step in taking an idea to market is to determine if the product can be profitable and if it can be certificated at a reasonable cost. The cost decision is influenced by the FAA's position on the certification of the product. This issue is often brought to the FAA at this stage to determine if the design would be prohibitively expensive to certificate. Aircraft Certification Office (ACO) engineers are normally the first point of contact for an applicant. The ACO will consult with the National Resource Specialist(s) (NRS) who has the most knowledge in the area. Directorates or the Headquarters Divisions may also be consulted.

Certification Plan

Once the company makes the decision to proceed, the applicant will normally apply to their local ACO and be assigned a project manager. The design will be firmed up and the certification plan presented to the ACO for review and approval. This represents a formal commitment between the applicant and the ACO on the guidance and regulations that are applicable to the project. The plan also should describe the division of responsibility between the ACO and the designees used on the project.

Preliminary System Safety Assessment

Also prepared at this stage is the preliminary system safety assessment. This is the document that establishes the criticality of the system and its various components. This determines the level of design assurance required by the regulations. It also establishes the software approval levels as required by the software development standard RTCA Inc. DO-178b document. The approval methods used for the software would then be documented and reviewed by the ACO in the Plan for Software Aspects of Certification. This document performs the same function for the software aspects of the certification project as the certification plan performs for the certification project as a whole.

FAA - Applicant Communication

During the design and development process it is important for the applicant to keep the ACO engineering personnel informed of all significant program actions. Design changes that were not anticipated in the certification plan may require additional certification effort to approve. Certification requirements that are identified late in the design process can often cause expensive modifications to be made to the system prior to certification. Unfortunately this consultation does not occur in all projects.

Test Plans

As the design becomes more and more mature, the test plans that will be used to demonstrate compliance with the regulations are developed and submitted for approval. Prior to the start of testing, the applicant will arrange to have a test article conformed to the design data. This conformity inspection is conduced by FAA Manufacturing Inspection District Office (MIDO) inspector or a Designated Manufacturing Inspection Representative (DMIR). The inspection establishes traceability from the design to the test article. The approved test plans are then executed on the hardware with either FAA or Designate Engineering Representative (DER) witnesses present.

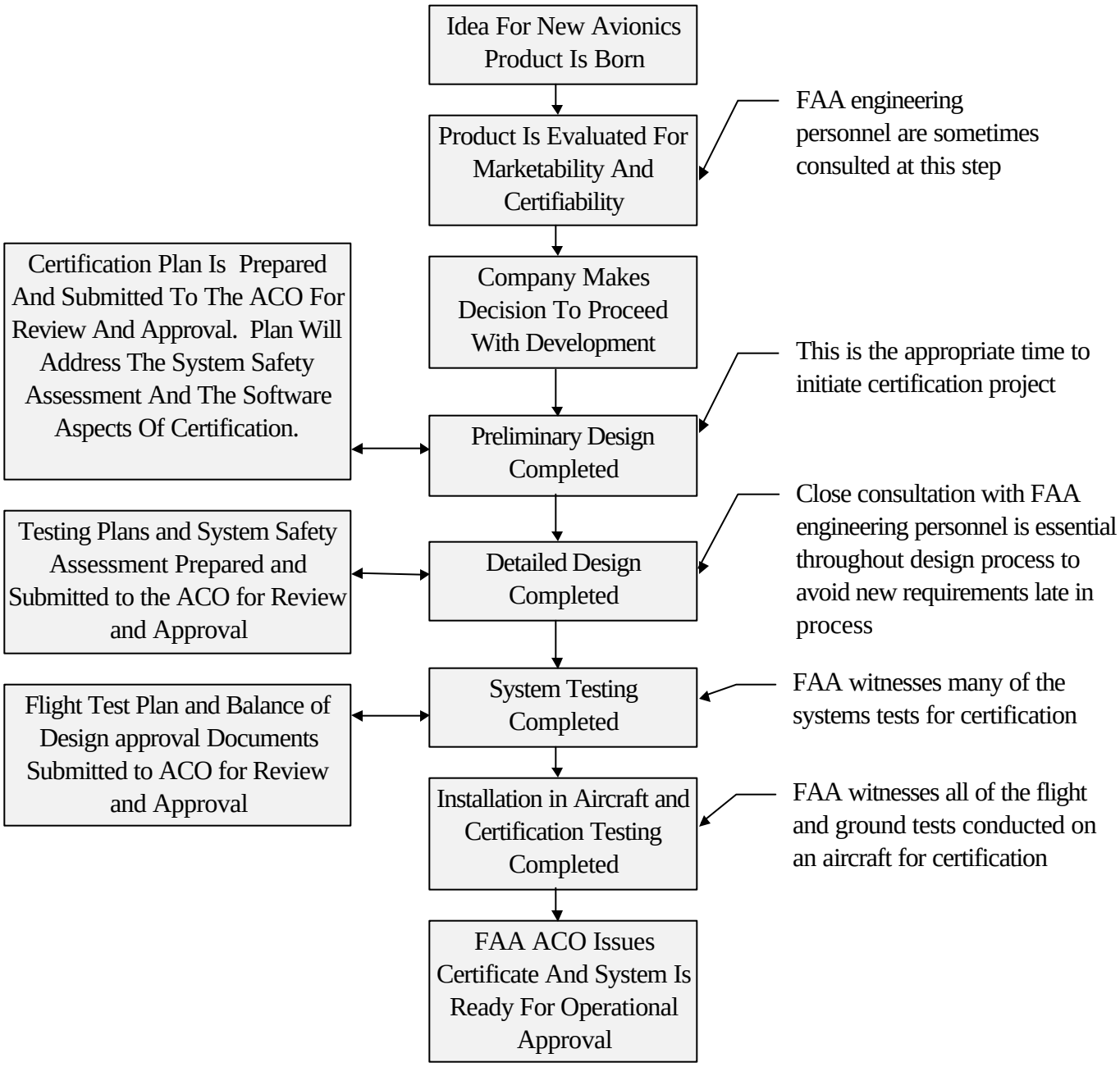
FAA Witnessed Testing

The final aspect of an avionics certification project is the testing that is performed on the aircraft. The airplane being approved must be conformed the same as the system components tested. This conformity is also conducted by MIDO personnel or their designees. The aircraft testing typically consists of both ground and flight testing. Ground tests are used to the greatest extent possible to save the applicant's cost. The flight testing can include both flight test pilots and flight test or systems engineer(s) depending on the complexity of the system under consideration.

Certificate Issued

Upon successful completion of all testing and analysis required by the regulations, the amended TC or Supplemental Type Certificate (STC) is issued.

DIAGRAM 1: ***This Diagram illustrates the TC or STC approval process.***



Design Approvals Using the Technical Standard Order (TSO) Process

Industry Standards

Most TSO's are based on an industry standard that comes from either the RTCA Inc. or Society of Automotive Engineers (SAE). Standards developed in these bodies are consensus standards developed under the guidelines of the Federal Advisory Committee Act. Because of the need for consensus and the large interest in new TSO's, these advisory committees take from 1 to 5 years to complete a standard. In the actual TSO document, the FAA recognizes the standard and addresses any changes or additions to the standard. This process has created a system that is slow to respond to the needs of a dynamic avionics industry.

The FAA TSO System

TSO compliance is voluntary and more restrictive than the mandatory TC/STC process. The rules and guidance governing the TC/STC process must be flexible to allow for innovation and specialization of products. The TSO System is defined in 14 CFR Part 21, Subpart O and implemented in FAA Order 8150.1a. The TSO process is more restrictive since compliance with the TSO is intended to allow for operation in any type of aircraft. This means that only the integration aspects of an installation approval need to be addressed when a product is labeled with a TSO number.

There are currently 110 TSO's published and available for use. Of the total 110, 71 are classified as Avionics TSO's. Most TSO's are for relatively simple hardware (for example, Safety Belts, Position Lights, Temperature Instruments, etc.). However, many of the Avionics TSO's are much more complex, such as: autopilots, Loran-C navigation equipment, GPS navigation equipment, multi-sensor navigation equipment, etc.

Most avionics manufactures want a TSO number on their products. It makes the installation approval much more simple and less costly. The TSO system is unique among certification approvals since the compliance finding is delegated to the applicant. The premise of the TSO is that the standard includes the testing requirements to demonstrate that a system complies. The applicant need only demonstrate compliance to the standard and then state in writing that the equipment complies. This is all that is required to receive authorization to label the equipment with the TSO number. This process is unique since the FAA is not responsible for making a compliance finding. The evaluation is more along the lines of evaluation of the applicant's ability to make the finding.

The guidance on granting TSO authorizations (TSOA) recommends a considerable effort be expended on first time applicants. However, as the applicant builds the confidence of the ACO on their ability to find compliance, the evaluation may be reduced to spot checks. In special cases, an ACO would accept the applicant's statement of compliance without any review of the data submitted. This method of design approval can significantly reduce the cost and time required to bring a new product to market.

A New Idea

Again the process begins with an idea for a new or significantly changed avionics product. However in this process the design is approved without reference to a particular aircraft type. The TSO process may only be used when a TSO exists for the product to be approved. If no TSO exists then the TC/STC process would be used for the design approval.

The Application Process

Because of the value of a TSOA, the existence of a TSO can have a great impact on the decision to proceed with development of a new product. However, if a TSO exists and the company determines that there is a market, then design begins. Reference DIAGRAM 2 for a graphical representation of the process being described.

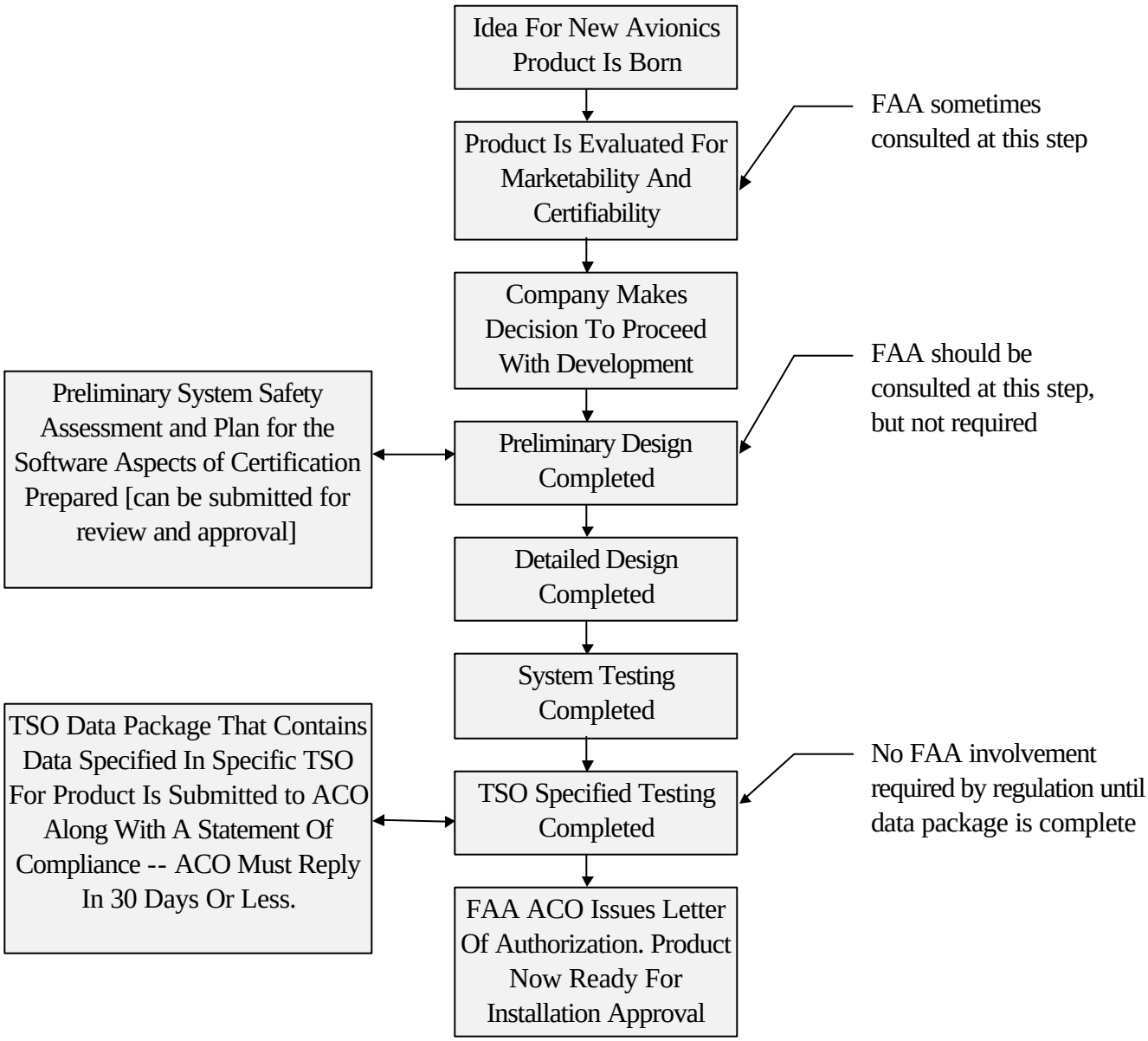
Because of the delegated nature of the system, the applicant is not required to submit any documentation of their process until the entire data package required by the TSO is complete. However, for complex avionics TSO's, the applicant is urged to consult with the ACO at the beginning of the project. This allows for concurrence with key documents, like the preliminary system safety assessment, and the software aspects of certification. This early review can identify any fundamental design flaws in a system prior to completion of the product and submittal of the TSO data package at the end of the project.

TSO Authorization

The internal process followed by a manufacturer is similar to that followed for an TC/STC project. However, the FAA would not typically be involved until all work was complete. Once the package is submitted the FAA has to respond with an acceptance or denial in a maximum of 30 days. Typical evaluation would be done by an engineer in the ACO and based only on the data submitted. For a first time applicant, the review would be extensive and could even involve a trip to the applicant's facility. The TSO also includes a production approval evaluation by the MIDO inspection personnel. The production approval is granted in conjunction with the issuance of a TSOA.

It is important to note that a TSOA is only a design approval of the functions in a piece of equipment that complies with the TSO. Systems that contain additional features that are not addressed by the TSO requirements must have those features evaluated on the first installation. The TSOA is not an installation approval for the equipment. Every new or replacement installation must be evaluated on the aircraft that it is installed in to determine if it functions properly in the aircraft.

DIAGRAM 2: ***This Diagram is For the TSO Approval Process***



Installation Approval Process Following A TSO Authorization (TSOA) For A New Product

Types of Installation Approvals

Obtaining a TSO authorization (TSOA) is only the first step to obtaining a design approval for an avionics system. All modifications to an aircraft must be properly approved according to FAR 43. If the modification changes the type design, then the change must have some form of engineering design approval. This approval can be data approved in one of three ways: under the Type Certificate (usually as a service bulletin), a Supplemental Type Certificate (STC), or data approved in conjunction with a field approval using an FAA Form 337.

If a TSOA product is intended to simply replace an existing TSOA product with little or no modification (like a radio), then little or no FAA involvement is needed. No certification effort is required if a system is replaced one for one. However, When new equipment is added to an aircraft that was not originally equipped with it, a type design change of some type is required.

Initial Approval Concept

Most avionics systems that have a TSOA are intended to be an added capability and are installed using the STC or FAA Form 337 field approval process. Most navigation systems have Advisory Circular guidance that allows the equipment manufacturer to obtain the initial STC approval and then to use the initial STC data to substantiate follow-on approvals. The follow-on approvals normally use the FAA Form 337 field approval process. This approach is encouraged for all avionics since the STC data package can greatly simplify the work of the field inspector.

The Approval Process

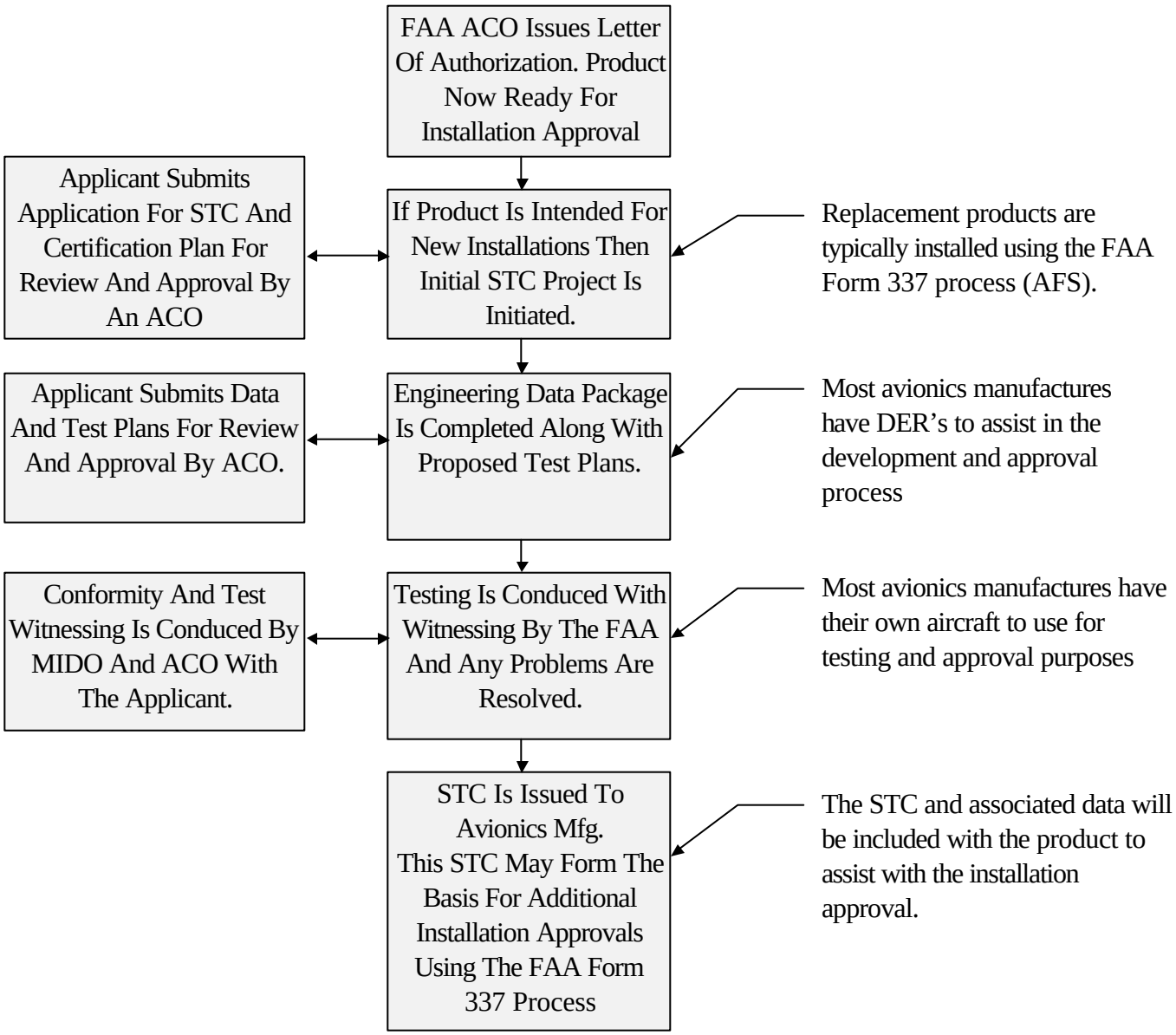
The process followed (see diagram 3) is the basically the same as in diagram 1, except that the functions of the equipment that are addressed in the TSO need not be reevaluated. The main purpose of the STC process in this situation is to determine if the product as installed still meets the minimum requirements for the avionics being evaluated. Original equipment manufacturers mostly have designated engineering representatives (DER's) to assist with the data evaluation and approval process.

The focus of the evaluation for a STC project for a TSOA article is the aircraft installation and the associated data. This data will be used for many other installations and must be evaluated for flexibility and completeness. The ground and flight testing associated with the project is a key to successful evaluation of the avionics. This testing is typically performed on an airplane owned or leased by the avionics manufacturer and operated as a test bed for their equipment.

This aircraft may not always be representative of all aircraft types that are targeted for the product being certificated. It is the installer's responsibility to make a determination that the installation of any new equipment is compatible with all existing equipment in an aircraft. This is why additional evaluation is

required for all installations that are based on the initial STC. This type of installation approval is sometimes referred to as a follow-on approval.

DIAGRAM 3: ***This Diagram is for the installation approval process following a TSO Authorization (TSOA) being issued for a new product***



Installation Approval Process Following An Initial STC Being Issued For A New Product Or For Replacement Products

Follow-on Approval Concept

The lowest level of certification involvement is in follow-on approval process (see diagram 4). This process is used to approve systems that have a TSOA and some form of type design approval, usually an STC. This process is most typically used by FAA licensed repair stations. Repair stations that offer an avionics system for sale also offer installation of the unit. Most manufacturers of avionics insist on selling only to installers for liability reasons.

The Approval Process

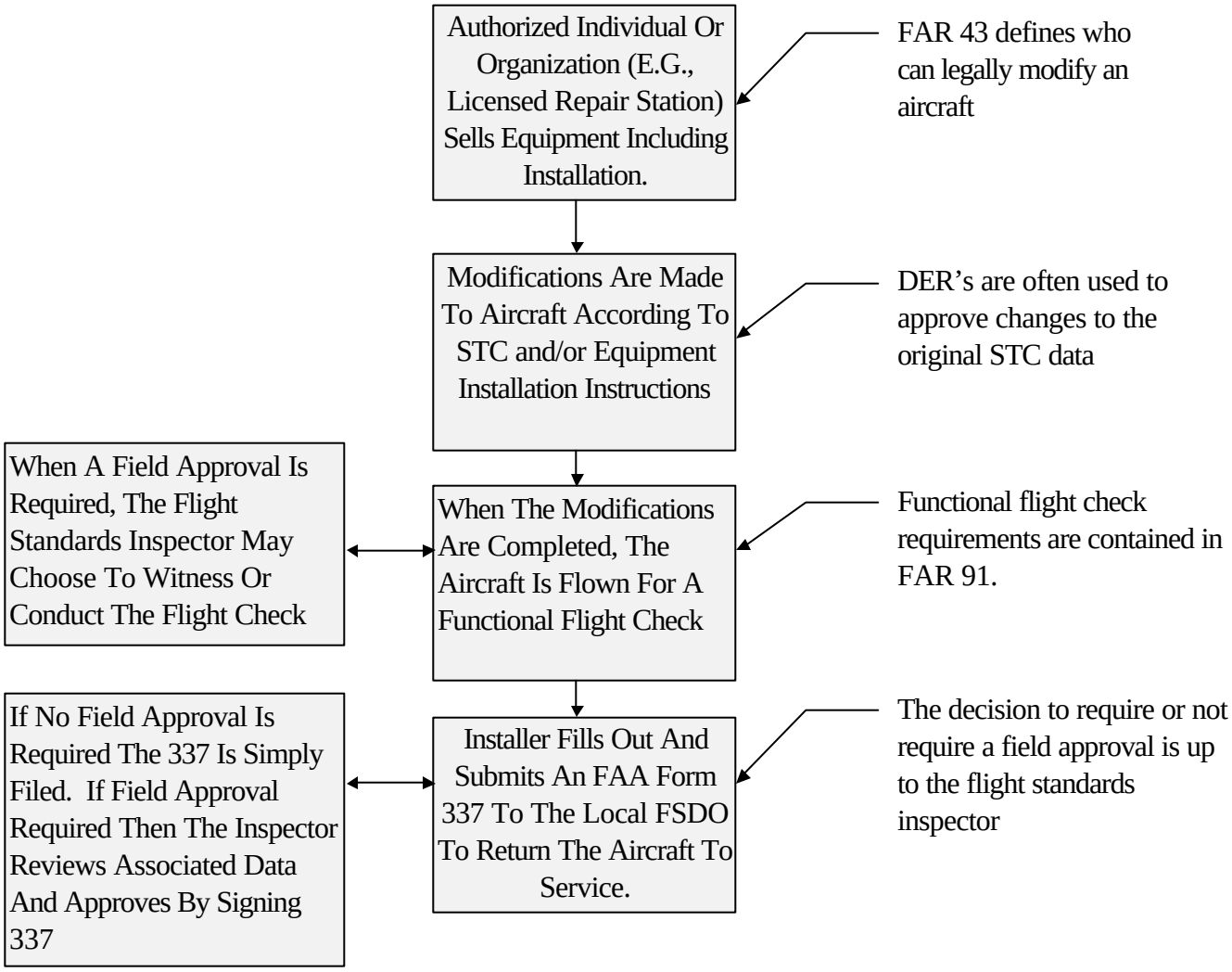
The process followed is mostly focused on installing the system according to the design data approved with the original STC and the manufacturer's installation instructions. However, any deviations from the original STC must be documented and approved either by an ACO engineer, a DER, or the field inspector. Approval of deviations from the STC is normal since very few in service aircraft are identical. Inspectors will evaluate the significance of the deviation and, based on criteria in the inspector's handbook, will make a determination on what level of approval is required.

This additional approval could even require a new STC in extreme cases where the inspector believes that the original does not apply. An example of this situation would be for a display system that is being used for primary flight information (e.g., airspeed, altimeter, attitude) when the original approval was for advisory information only (e.g., weather radar, navigation map). In most cases the changes do not change the validity of the original STC and the inspector will approve the differences.

In situations where no changes to the original STC are required, the repair station is authorized to return the aircraft to service without any approval required by the FAA. The FAA Form 337 is signed by the repair station and forwarded to the local Flight Standards District Office (FSDO) for filing. This type of approval is not allowed when the STC is being extended to a different aircraft than the one originally used for the STC.

When FAA participation is required, the inspector can require a functional flight test be performed and this flight can be witnessed by the FAA. Many guidance documents require this functional flight check as a part of follow-on approvals (e.g., GPS and Loran navigation systems). Once the flight check is completed the inspector returns the aircraft to service by signing the FAA Form 337. The 337 process is described in detail in the FAA Inspectors Handbook, Order 8xxx.x.

DIAGRAM 4: ***This Diagram is for the installation approval process following an initial STC being issued for a new product or for replacement products.***



Review

- The type certificate (TC) process is used by airframe manufactures to approve avionics for new aircraft or upgrades for existing in production aircraft.
- The supplemental type certificate (STC) process is used to approve systems that are intended for in service aircraft upgrades or to add new capabilities.
- The Technical Standard Order TSO system is used to approve standard systems at the component level to simplify the TC or STC approval process.
- The FAA Form 337 process is used to approve the installation of equipment that has been previously approved by FAA engineering (i.e., TC, STC, and/or TSO) and to return the aircraft to service following modifications.
- The Applicant is ultimately responsible for demonstrating compliance to the FAA that their design meets all applicable Federal Regulations.